Association of *Diplodia pinea* with a Root Disease of Pines in South Africa

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ABSTRACT

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Diplodia pinea is an important factor in a root disease of *Pinus elliottii* and *P. taeda* in various parts of South Africa and Swaziland. All stands in which the disease occurred were severely stressed.

Diplodia pinea (Desm.) Kickx occurs throughout the conifer-growing areas of the world and is associated with a wide range of symptoms, including bark cankers, bud wilt, dead top, seedling blight, seedling collar rot, staghead, and twig blight (1,3,4,9,12). In South Africa, *D. pinea* causes serious dieback of *Pinus patula* Schl. & Cham., *P. pinaster* Ait., and *P. radiata* D. Don. after hail (5,7,8) and is regarded as the most important pathogen of pine plantations (8,15). Control is largely by restricting planting of susceptible species to areas where hail damage is limited (5,6) and by replacing susceptible species with the more tolerant *P. elliottii* Engelm. and *P. taeda* L. in the summer rainfall area (5–7).

Since 1975, extensive losses have been caused by a root disease in *P. taeda* plantations belonging to the Usutu Pulp Company in Swaziland (D. G. M. Donald, *personal communication*). During a preliminary survey of local forest tree diseases, the senior author examined the diseased trees in Swaziland and observed similar symptoms on *P. elliottii* and *P. taeda* plantings in various parts of South Africa. This paper describes the association of *D. pinea* with the disease and compares three isolates of the pathogen.

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MATERIALS AND METHODS

Isolations were made on half-strength MEA with vancomycin (M. J. Wingfield and P. S. Knox-Davies, *unpublished*) from the roots and root-associated stem lesions of dying *P. elliottii* and *P. taeda* from various parts of South Africa and Swaziland. After 1 mo at 15 C under near-ultraviolet light, plate cultures of isolates from the following sources were compared: 1) root lesions of *P. taeda* from the Bulwer area in Natal (PREM 45508), 2) stems of blighted *P. patula* seedlings from Cedara, Natal (PREM 45507), and 3) *P. radiata* (ATCC 34924) supplied by C. K. S. Chou of the New Zealand Forest Service, Rotorua. The effect of temperature on growth was evaluated by measuring colony diameter in 90-mm petri dishes with 25 ml of MEA after 4 days at 10, 15, 20, 25, and 30 C.

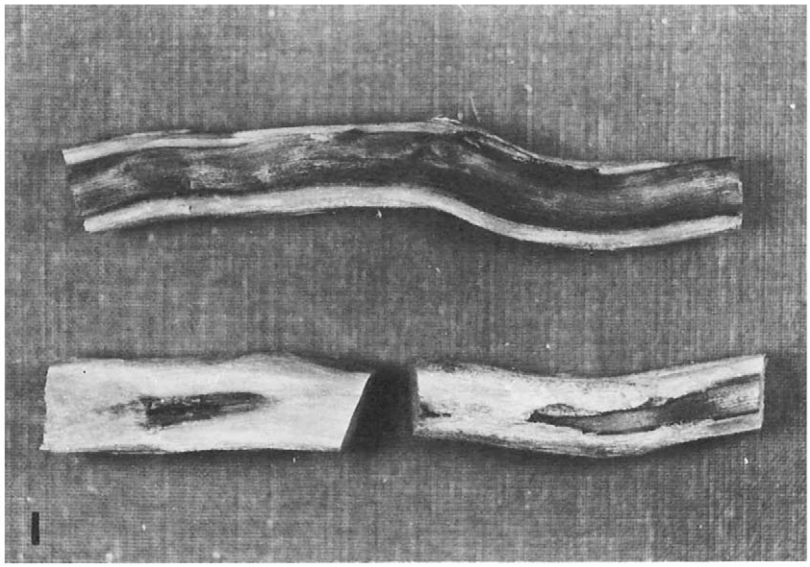
Two-yr-old *P. taeda* nursery plants were inoculated with the *P. taeda* root isolate. Toothpicks colonized by *D. pinea* were forced into the taproots or growing tips of trees; 20-mm wooden dowels boiled in potato-dextrose broth and colonized by the fungus were tied to nonwounded taproots. Noninoculated toothpicks and dowels were used in control trees. Trees with root inoculations were repotted, and all trees were then kept in the open. Ten-yr-old *P. elliottii* trees were inoculated in the field as described for *Verticicladiella alacris* Wingfield & Marasas (M. J. Wingfield and P. S. Knox-Davies, *unpublished*). There were 10 nursery plants or trees in each treatment.

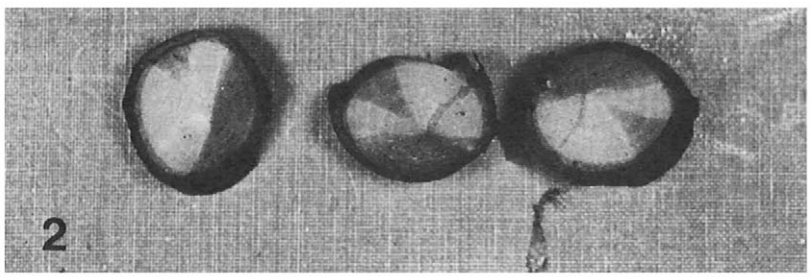
RESULTS

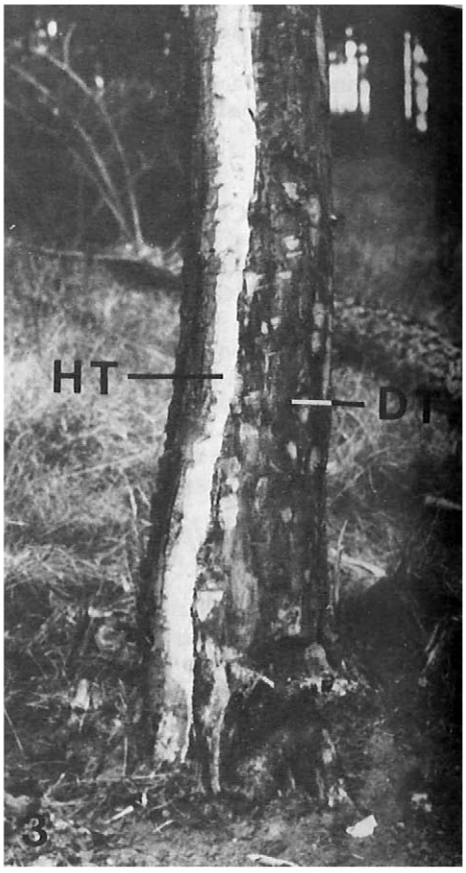
Symptoms. In one 600-ha compartment in Swaziland, more than 50% of the trees died. Where *P. elliottii, P. patula,* and *P. taeda* were in proximity, *P. patula* was unaffected and *P. elliottii* was less affected than *P. taeda*. Infected trees were usually scattered throughout the plantations, and aboveground symptoms after natural infection were chlorosis, needle fall, and, in some cases, death of tops. At an early disease stage, the smaller roots exuded resin and transverse sections revealed dark-blue lesions in radial sectors (Figs. 1 and 2). At a later stage, radial lesions were also seen in the larger lateral roots. Finally, lesions extended into the tree trunk (Fig. 3), in some cases up to 2 m above the ground. Resin sometimes exuded from the bark over the lesions. With severe disease, several lateral roots were infected and a number of lesions developed in the trunk. In some cases, stem and root lesions were overgrown by a wound periderm. Dead and dying trees were often windblown. Root systems of healthy trees in contact with diseased roots were also infected.

Distribution. Root disease was recorded on *P. elliottii* and *P. taeda* in the Usutu Estates, Swaziland; on *P. elliottii* in the Claremont Plantation, Natal Midlands, the Elandshoogte Plantation, Eastern Transvaal, and the Cubusie Plantation, Eastern Cape; and on *P. taeda* in a private plantation in Paulpietersburg, Natal.

Site conditions. All stands in which disease occurred were severely stressed. Drought was a common factor. In the Usutu Estates and Elandshoogte Plan-







Figs. 1–3. (1 and 2) *D. pinea* lesions on *P. elliottii* roots. **(3)** *D. pinea* lesion on *P. elliottii* trunk. HT = healthy tissue, DT = diseased tissue.

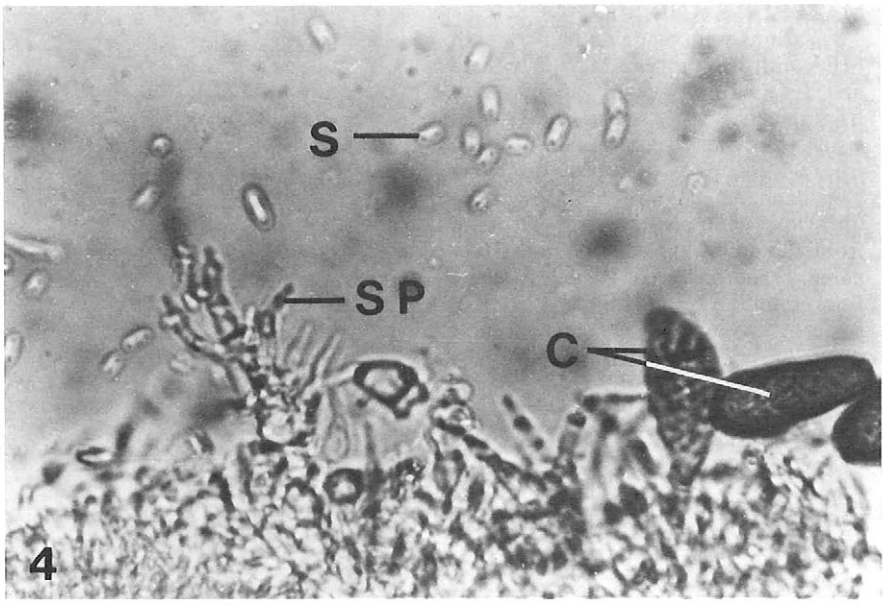


Fig. 4. Conidia (C), spermatiophores (SP), and spermatia (S) of *D. pinea*. (×700)

tation, trees were on a pulpwood rotation and were overstocked. Unthinned stands and poor planting sites were other stress factors.

Comparison of isolates. Isolates from root and trunk lesions from all areas consistently yielded *D. pinea*. Isolates of *D. pinea* from PREM 45507, PREM 45508, and ATCC 34924 were morphologically indistinguishable; conidia, spermatiophores, and spermatia were observed (Fig. 4). Spermatia were 2.4–6.0 × 0.9–1.8 μm, hyaline, and cylindrical with rounded ends and flattened points of attachment. They exuded from the ostioles of the pycnidia in a translucent mass that later darkened. Growth rates of the cultures were slightly different, but the optimum growth temperature for all three isolates was between 25 and 30 C.

Inoculation studies. All trees inoculated in the taproot died within 1 mo, whereas controls remained healthy. Diseased roots were stained but no radial lesions were observed, as in naturally infected trees. All trees inoculated in the tip showed tip dieback. After 5 mo, *P. elliottii* inoculated in the field had darkened lesions around the point of inoculation.

DISCUSSION

D. pinea has not been previously reported to cause a root disease of conifers with symptoms similar to those observed in our study. The pathogen is known to kill trees close to the root crown area (16) and to cause collar rot of conifer seedlings (12). It is also reported to cause root disease of 3- to 5-yr-old *P. resinosa* Ait. in nurseries and 6-yr-old *P. strobus* L. in plantations (2). Our observations suggest that *D. pinea* is an important factor in the root disease of *P. elliottii* and *P. taeda* occurring in South Africa. Because the pathogen has often been associated with stress conditions (1, 10–14), its association with an apparently new disease symptom of stressed pines is not unexpected.

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